
Science 2.0 and Visual Data Exploration using Augmented Reality

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Abstract

This paper describes a research effort to use information visualisation and augmented reality for data exploration in conferences and scientific meetings. We summarise the iterative design and evaluation process of an interactive display that allows users to discover scientific publications and connect with peers. We present preliminary evaluation results, and point out future developments and research directions.

Author Keywords

Science2.0; Visual Data Exploration; Augmented Reality

Introduction

Science2.0 is the result of applying Web2.0 tools and approaches to regular research processes in order to increase participation and collaboration among researchers [15, 16]. One of the key goals of Science2.0 is to support the connection between researchers to stimulate cooperation. In this paper, we focus on the scenario where attendees of a conference, seminar or workshop want to discover new information on the topic of the event. The attendee may be interested in finding new papers related to the topic and in connecting with the authors of those papers.

ConferExplore, our mobile application, couples this discovering phase with personal Web2.0 data of the attendee through augmented reality.

Related Work

Discovering papers and authors is a key activity of a researcher. Several Web2.0 tools exist to find, organize, and collect papers and authors [6, 8]. However, these tools provide no integration with events, such as conferences, seminars and workshops.

There exist Web2.0 tools that try to enhance the experience of such events by allowing users to explore and organize their conference schedule [2, 3]. Conference Navigator [17] supports adding of papers to favorites and recommending of papers to other users.

The use of augmented reality (AR) increases, both in research and commercial applications [3, 4]. AR aims to enhance the user experience by merging the real and the virtual worlds and providing context-sensitive interaction.

AR provides a new way of interacting with the data [18]. To facilitate this interaction process, research has looked at what real-life objects and images can be tracked and augmented [11, 14], the displays and augmented surfaces on which the augmented reality can be shown [10] and which particular augmented information is relevant to the user [13]. Recent applications allow the user to choose any object as a tracker to visualise an augmented two or three-dimensional object [1, 7].

Context

The research in this paper focuses on combining information visualisation and AR to build visual displays that allow users to discover information about scientific publications, and strengthen networking between attendees of a scientific event.

This setup has two main purposes: (i) giving participants an overview of the conference papers presented at the conference and their authors, and (ii) allowing participants to interact with visual data, discover new papers, and enable peer networking and collaboration through a third party software.

ConferExplore

The development of ConferExplore followed an iterative and rapid-prototyping approach [12]. This iterative process resulted in two paper and three digital prototypes.

ConferExplore integrates discovery of papers and authors at conferences, into the collection and organization workflow of the researcher. The setup divides the space into a static space on a display, where the network visualisation is shown, and an interactive space on the mobile screen, where visual data is enriched with Science 2.0 functionality.

First, the scientific publications and their authors are displayed as a network on a wall, using a screen, projector or poster (Figure 1).

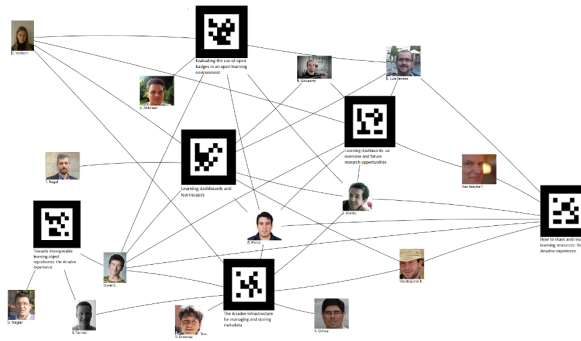


Figure 1. Network visualisation with scientific publications and their authors.

The static display is then made interactive through AR, and the data integrated with Science 2.0 software. More specifically, the current version of ConferExplore provides integration with the reference manager Mendeley [6]. The augmented interface adds Mendeley functionality on top of the visualisation of papers and authors, linking visual data with the user's Mendeley account, and allowing managing the user's library and contacts, as explained in the following:

- **User's Library:** Paper markers are augmented showing if the paper is already part of the user's library, as seen in Figure 2. Tapping the button can add the paper to or remove it from the reference manager.
- **User's Contacts:** Profile pictures are augmented giving an indication of whether an author is part of the user's Mendeley contact list (Figure 2). The author can be added or removed from the contact list through the mobile device.

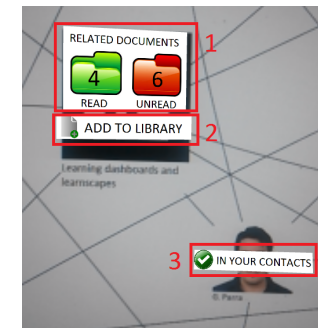


Figure 2. Network visualisation with augmented information about papers and speakers at a conference.

The current prototype builds upon the results of previous models. It corrects a number of usability and efficiency issues to provide an improved interaction and more robust performance. It is also the first prototype used in a real life setting.

From the 28th of April to the 2nd of May 2014, ConferExplore became the official application of the Tenth Joint European Summer School on Technology Enhanced Learning (JTEL Summer School) in Malta [9].

Five network visualisations, linking information about lectures, workshops and presenters of the Summer School, were displayed as daily interactive posters in the main hall of the venue. DIN A4 copies of the network visualisations were also made available to all the participants (Figure 3).



Figure 3. A participant of the JTEL Summer School 2014 using ConferExplore.

The mobile application was spread amongst the summer school attendees through mail and Facebook. Users could download the software from a website or use the tablets and phones that were provided at the event. The website contained also download and evaluation instructions.

Evaluation

The evaluation took part on the fourth day of the Summer School, during the workshop 'Educational Augmented Reality: Methodology and Application'. The participants in the workshop took part in a search game constructed around the application. In the game, the participants were asked to form teams and work together to look for network visualisations distributed along the conference venue, and answer to questions about their Summer School peers and their scientific publications (Figure 4).



Figure 4. Participants of a collaborative search game constructed around ConferExplore.

Eleven participants (age 27-41, 6 male, 5 female) responded to an online survey and provide information about their experience with ConferExplore. Figure 5 shows Likert-scale box plots for the intended use of ConferExplore, and compares them with the results obtained previously in the laboratory.

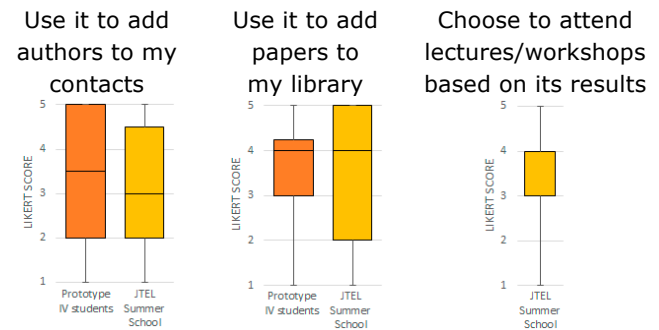
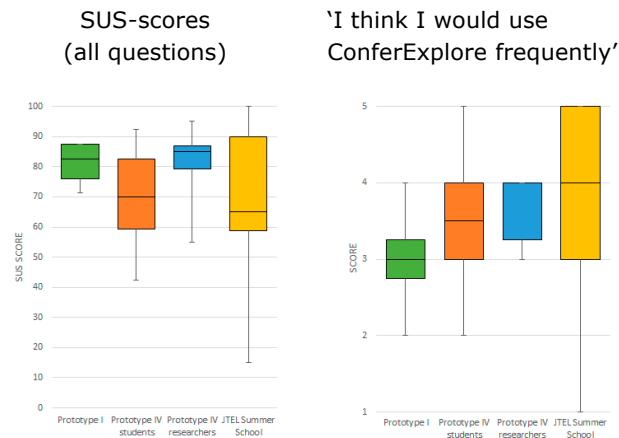


Figure 5. Intended use of ConferExplor. Likert values comparing a previous laboratory study (orange) with users' responses at the JTEL Summer School 2014 (yellow).

The participants were also requested to fill out a SUS-questionnaire. ConferExplore received an average SUS-score of 66. This result, which is significantly lower than that of previous prototypes (Figure 6), can be due to the fact that this was the first real life trial.



Green - Prototype I

Orange - Prototype IV (students)

Blue - Prototype IV (researchers)

Yellow - JTEL Summer School 2014

Figure 6. Evolution of SUS-scores during the evaluation cycle.

Taking a closer look at the distribution of the scores on the question 'I think I would use ConferExplore frequently', the median is 4, which is higher than previous prototypes. This result can probably be explained by the fact that researchers who are familiar with conference settings value the use of interactive displays and mobile devices to help discover scientific publications and connect with peers at conferences and scientific meetings.

Overall, the results of this experience are very encouraging, as they confirmed the perceived usefulness and potential benefits of ConferExplore.

Conclusions and Future Work

In this paper, we discussed the integration of information visualisation and augmented reality for visual data exploration and collaboration. We summarise the development process and evaluation of ConferExplore, a Science 2.0 application that builds on visualisation and augmentation to allow users to discover scientific publications and connect with authors at conferences and social scientific events.

The current version of ConferExplore allowed lecturers, senior researchers and Ph.D students participating in the Tenth Joint European Summer School on Technology Enhanced Learning [9], to consult the daily program, interact with the information about presenters and their papers, and decide on the topics of the lectures and workshops. The evaluation, combining an on-line survey and a SUS-questionnaire, proved this approach to be effective in a real setting, and pointed out areas for further improvement.

Directions for further research include (i) evaluating the use of different kinds of interactive surfaces, such as tabletops and interactive walls, and comparing the results with those obtained through static displays and AR, and (ii) looking into the social aspects of the application to see how ConferExplore can further enhance collaboration and social interactions.

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